

Avoiding Interference

Multiple Methods for Frequency Interference Avoidance:

- **Dynamic Channel Avoidance Techniques**
- **GMSK Modulation Techniques**
- **Adjustable Power of Transmission (pfd)**
- **Adjustable Transmission Duration Time**
- **Frequency Agile Flight Radios**
- **On-Board Computing Capacity**

Summary

Summary

- ◆ Flexible applications
- ◆ Flexible data read and retrieval
- ◆ Flexible data processing
- ◆ For a variety of industries and agencies
- ◆ Limited by the creativity and imagination of the user
- ◆ With a simple design and economies of scale for low cost service
- ◆ Scaleable to meet growing needs and capital limitations





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For Immediate Release

FAISAT-2V™ Satellite Headed for Russian Launch

Lanham, Maryland -- Final Analysis Inc. will ship its "one-of-a-kind" demonstration satellite, FAISAT-2V, to Russia this week for launch from Plesetsk Cosmodrome. The launch is scheduled for late March over the Cosmos rocket. Press is invited to view the satellite, the "high bay" facilities, and the mission control center at the Final Analysis headquarters in Lanham, Maryland, on March 4-5.

Final Analysis, an entrepreneurial company in an emerging satellite technology field, is planning to deploy a global constellation of 26 commercial telecommunication satellites into low earth orbit for low-cost global data messaging and acquisition. These "infosats" will deliver new digital data services with a wide range of market applications such as digital voice mail, two-way paging, utility meter reading, environmental monitoring, and asset tracking on trucks, boats, and trains.

FAISAT-2V is designed and built by Final Analysis pursuant to an experimental authorization from the Federal Communications Commission. An innovative "Awareness Program" offers governments around the world six-months free access to the satellite and the use of up to ten remote terminals. National policy makers and regulators of ten countries have agreed to participate in this program: Brazil, Colombia, Germany, Indonesia, Mongolia, Poland, Russia, Senegal, Uruguay, USA.

Final Analysis is a privately-held aerospace and telecommunications company committed to space commercialization and the peaceful uses of outer space. The company has forged a strategic relationship with Russia's Polyot Design Bureau, one of the world's largest aerospace companies. Polyot will launch FAISAT-2V from Plesetsk in northern Russia.

For facilities tours and interviews, call Mary Kay Williams or Sharon Edwards at 301-459-4100.

##



Corporate Overview

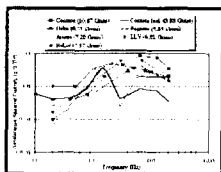
Final Analysis is a privately-held aerospace and telecommunications company. Specializing in innovative approaches to small satellite production, the company was founded in 1992 on a commitment to space commercialization through low cost access. Final Analysis, Inc. is headquartered in Lanham, Maryland with manufacturing operations located in Lanham, Maryland and Logan, Utah and field offices in Russia and Geneva. Within the first four years of operation, Final Analysis has grown from a small engineering contractor to an end-to-end turnkey provider of spacecraft, operations, and launch vehicle services. In short, the company's products and services can be split in four main categories:

- Global Digital Communications Services ("Little LEO MSS")
- Satellite Development
- Aerospace Engineering Services
- Secondary Payload Services

The company's core competencies can be summarized as follows:

- | | |
|------------------------------------|---|
| • Program Management | • Loads & Dynamics |
| • Systems Engineering | • Thermal Analysis |
| • Electrical Design | • Structural Analysis |
| • RF & Communication System | • Assembly & Fabrication |
| • Flight Software | • Test & Integration |
| • Orbital Mechanics | • Integration & Operations |
| • Trajectory & Mission Performance | • Satellite & Launch Vehicle Applications |

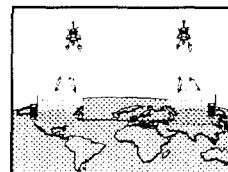
These core competencies fall within the satellite, launch, ground systems and operations domain.



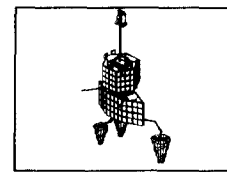
Aerospace
Engineering
Services



Satellite
Development



Communications
Services



Secondary Payload
Services

Communication Services

The subsidiary, Final Analysis Communication Services, Inc. (FACS), is a leader in the development of new global store and forward digital data communications. The constellation will consist of satellites known as "Little LEOs" or "Infosat" systems, which provide two-way global data packet communications. The company is launching a 26 satellite constellation of low earth orbiting satellites, with 4 in-orbit spares, to support the business operations of its communications services subsidiary. The system provides data acquisition, messaging, tracking, control, and alert services for ground assets located anywhere on earth. With low user terminal and service costs, this system enables new information and control scenarios for government, industrial, business, and personal applications. Applications are varied and include messaging, two-way voice mail, alphanumeric paging, and remote Email access. In addition, the satellite constellation will be applied to automated meter reading (AMR), environmental monitoring, fixed and mobile asset management and tracking, computer file transfer and more.

Secondary Payload

In addition to its own satellite development and contract-based development projects for private and Government clients, Final Analysis has established the FAISAT Secondary Payloads Program in support of its defense conversion and space commercialization efforts. The program offers assistance to Government, scientific, and academic organizations involved in space flight experiments. The company has reserved secondary payload slots on each of its 30 commercial satellites scheduled for launch between 1998-2002. Extra power, mass, data storage, and telemetry & command were created for science experiments or new technology demonstrations. The company's turnkey services, which include satellite bus, payload accommodations, launch, and data transfer, are all offered for one low base fee. The fee is expected to be paid only upon achieving orbit. Consequently Final Analysis assumes the risk. This service is a unique opportunity to piggyback on a commercial mission for a low cost, low risk, quick access to space.

AE Services

Final Analysis provides a broad range of aerospace engineering services in the satellite, payload, and launch vehicle domain. Services include studies, analysis, systems engineering, design and drafting, independent verification, fabrication and test of satellite subsystems, boxes, and components. Services can be applied to a variety of needs such as technology assessments, feasibility studies and system comparisons. Final Analysis provides these at low rates, with skilled personnel, and with a full set of tools and facilities.

Satellite Development

The company develops and manufactures small satellites, for its commercial services. These satellites can also be used for science and new technology mission applications. The satellites are robust with powerful onboard computerized systems, large onboard data storage capabilities, a state of the art communication and RF System, and a flexible mechanical design. The satellite bus is built at production-quantity cost. Customers can benefit from the production-quantity cost amortization of non-recurring engineering over the commercial service, as well as the economies of scale of multi-unit procurement.

Summary

Final Analysis consists of entrepreneurial management, creative business solutions and innovative technical solutions. With a skilled team, proven tools, low overhead, space qualified facilities, Final Analysis offers low cost services and access to space for commercial and government agency customers.

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Little Leo ("Infosat") Policy Issues: The Final Analysis Viewpoint

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I. What are Infosats?

Infosats are "Little Leo" non-voice mobile satellite service constellations operating below 1 GHz and offering a new generation of non-voice digital data and messaging services. The system proposed by Final Analysis will consist of 26 satellites operating in inclined orbit at an altitude of approximately 1000 kilometers above the earth. Infosat system design is derived from the advances in aerospace technology. The commercial adaptations of this technology permit the global delivery of advanced data services at very affordable rates.

The potential applications for Infosat technology are potentially endless. Uses can be found for this technology in any aspect of commercial, governmental, environmental, educational and health and safety activities where reliable and inexpensive data and messaging services are required. Applications will touch remote villagers and multinational corporations alike with affordable information services.

For example, Infosats can: ~ make possible virtually instantaneous data transmission for collection, analysis and dissemination of lifesaving information on infectious diseases; ~ facilitate sophisticated medical analyses of complex cases remote from medical centers; ~ provide virtual real time safety and alarm monitoring in areas not otherwise served by telecommunications; ~ facilitate delivery and sharing of educational materials to remote locations; ~ provide geo-positioning analysis for everything from trucks and cars to children and priceless paintings; ~ read thousands of utility meters and perform utility billing within seconds and for a fraction of the current cost, helping to substantially reduce the price of basic utility services; ~ provide early warning of hurricanes, earthquakes, volcano eruptions and other environmental and climatic disasters; ~ make available universal voice mail and email access; and ~ provide cutting edge global risk management data services for multinational financial institutions.

Infosats provide a ubiquitous information infrastructure -- available to users in any country for mere cents per minute.

II. How do Infosats Work?

Subscribers can access Infosats either through "Message Terminals" ("MTs") with alphanumeric keypad for personal messaging or voice mail and two-way paging of field-installed "Remote Terminals" ("RTs") for data acquisition applications such as remote meter reading or computer file transfer.

Infosats revolve around the earth in just over 100 minutes, and are arranged in space so that, effectively, there is always a satellite "in view." From virtually any location on earth, a user equipped with either a hand-held global mobile communicator or a personal computer at a fixed site, can send and receive alphanumeric messages, and computer files. In the case of voice mail systems, users speak into a voice digitizer to store and forward a message. The ground terminals signal the satellite overhead and the message is sent. The satellite, with its broad footprint... about the size of most continents...immediately retransmits the message to the addressee. When the sender and receiver are within the same satellite footprint, the message transmission is near-instantaneous. Communications can involve many types of users and messages...alphanumeric text...digitized voice...position and direction of any cargo or asset...any type of environmental data or other sensor output...to meet a variety of personal, government, and industrial needs.

In instances when the sender and the receiver *are not* within the same satellite footprint, the Infosat system stores and carries the message to its destination...anywhere on the globe. This store-and-forward feature enables a host of applications including ship-to-shore communications, trans-oceanic shipping, ocean monitoring, global and polar region environmental monitoring.

In scenarios where a global or transcontinental message must be delivered within near real time, the satellite over the sender will immediately re-transmit the message to the nearest ground station within its footprint. At the Network Control Center, the message will be processed and forwarded, via terrestrial network systems or by Internet, to the ground station closest to the addressee. The receiving ground station will, in turn, transmit the message to a satellite overhead where it will be carried for final delivery to the addressee.

This example demonstrates the system's inter-operability with local terrestrial systems and the Internet. Using a combination of gateway stations, satellites, land-based lines and the Internet, quick reliable digital data service is available to everyone....everywhere.

III. How can Countries Participate in Infosats?

Infosats essentially will serve as a ready-made orbiting information highway. They will be built and "installed" at the risk of the owners of the Infosat constellation, without the need for infrastructure investment by every country that will use it. The owners will operate the satellite facilities on a "wholesale" basis. The Infosat highway then can be accessed by

enterprises authorized by individual countries all across the globe. Thus, countries may participate by authorizing local companies to develop commercial services using the Infosat data communication capabilities.

The services that can be provided over the Infosat highway may be international, such as transportation tracking, but they also may be purely domestic, including paging, health and safety and educational services. National service providers will remit money to the constellation owner for use of the highway, but otherwise may keep a substantial amount of the revenue for their own account.

National authorities may decide whether to authorize one or more national service providers. Several national service providers may operate in conjunction with the same Infosat constellation, providing different services. The system owners also can work with national entrepreneurs to develop innovative service applications.

Of course, any country may license its own Infosat system, duly coordinated through the ITU. Such systems may operate independently, or actually may be designed to operate in conjunction with another Infosat consortium.

IV. What are the Spectrum Requirements for Infosats?

Infosats, which will operate below 1 GHz, require relatively little spectrum to operate, and in fact require an extremely small amount of dedicated spectrum for downlink operations. Infosats have several characteristics that minimize spectrum requirements.

First, Infosats are very spectrum efficient, and require only a few MHz to operate at any one moment. Second, Infosat transmissions are in the form of packetized intermittent "bursts," and do not continuously occupy the spectrum that is used. Consequently, Infosat transmissions can "time share" spectrum with a number of other services. Third, Infosats are designed so that transmissions can "protect" other terrestrial operations by delaying transmission when a station subject to interference may be transmitting. Finally, Infosats are designed to be frequency agile, and can operate on different frequencies, depending upon the region that is passed.

Allocations for non-voice mobile satellite systems at the 1992 WARC and WRC-95 are inadequate. As a result, a small amount of additional spectrum should be allocated for Infosats at WRC-97. It may be difficult to identify a small amount of dedicated spectrum that can be used in all regions. However, that may not be necessary.

Final Analysis believes that the best approach to allocation of additional spectrum for Infosats is to identify a broad block of spectrum for global allocation within which individual countries and regions can identify specific spectrum for Infosat operations within their geographic area. This will permit all countries to meet domestic requirements while still ensuring global implementation of Infosats.

V. How can Unauthorized Uses be Controlled?

The MT devices will operate in much the same way as other mobile phones and similar consumer electronic devices. National authorities can apply the same type of regulations to all such terminal to ensure that only approved uses are made of the devices.

With respect to RT devices, many of them will be used for remote metering and utility monitoring and other data collection services. Terminals used in these applications may be authorized on a system-wide or "blanket" basis, obviating the need for individual authorization of each terminal. The system implemented for each customer (which may involve thousands of RTs for one utility, for example), will be required to comply with specific operating parameters.

Other RT applications, however, including those for asset tracking for transportation companies or lost vehicle recovery, will include navigation and/or location devices. This capability, installed within the terminal, will greatly facilitate control of unauthorized operations.

VI. Is Transborder Roaming of Terminals Important?

Global roaming will be very important for certain Infosat service applications, including asset tracking for international shipping and international paging and messaging. Roaming arrangements, as well as mutual recognition arrangements will assist developing countries by enabling them to more efficiently access Infosat services and relieving them of the significant time and expense of developing individual standards and conducting individual authorizations, for which most developing countries have few if any resources.

VII. What Regulatory Issues Must Participating Countries Address?

First, administrations that desire to facilitate implementation of Infosat services in their countries must address frequency allocation and coordination issues, particularly as they will be discussed at WRC-97.

Second, national authorities will need to determine an approach to licensing national service providers. It is recommended that any licensing requirements be kept to a minimum and that the market for national service providers be kept open to full competition. Several different Infosat systems are in development and several applications may be authorized in conjunction with any one system. There may be a broad market in each country for several national service providers, providing similar or different service applications to end users. Keeping the market open to competition will keep prices low and will inspire entrepreneurial development of innovative services.

Third, national authorities will need to develop an approach for technical approvals of terminals for end users. It is necessary to control unauthorized use and prevent undesirable

interference. However, it is also advisable to streamline the approvals process for such terminals as much as possible in order to facilitate implementation and remove unnecessary barriers to realization of the benefits of Infosat services. Entry into bilateral or multilateral mutual recognition agreements or other such arrangements may be very helpful in this respect.

Fourth, a related issue is enforcement of unauthorized use. Publication of sanctions and penalties for unauthorized use would be helpful as a deterrent.

Fifth, it may be necessary to apply some rate regulation, non-discrimination requirements or other fair trading rules to Infosat services to protect end users. However, it is anticipated that the emerging globally competitive environment for such services will be the best protection for users, and it is hoped and anticipated that significant ongoing service regulation will not be required.

VIII. How can Countries Learn More About Infosats?

Final Analysis has initiated an experimental program to test the operations and applications of its proposed Infosat system. Its second experimental satellite, FAISAT-2, authorized by the U.S. Federal Communications Commission, is scheduled to be launched within the next few months. Final Analysis invites all interested countries to participate in tests using this experimental satellite.

Participation in this experimental program will enable national policy makers and regulators to gain first hand "real-world" experience with this new technology, and most importantly to learn how this technology and its applications can benefit their citizens.

THE FINAL ANALYSIS LITTLE LEO: A SYSTEM AND SERVICE OVERVIEW

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Abstract:

There is an emerging commercial space industry consisting of constellations of low earth orbiting satellites to that will provide global telecommunications services. Within the set of proposed low earth orbiting satellite systems, there exists two distinct classes. One class provides high bandwidth digital voice and data services, and the other provides narrowband store and forward digital data services. The digital data service systems are called Little LEOs or Infosats. These systems will provide a variety of personal, business, environmental, and industrial digital data services on a global scale. Infosat systems provide a niche telecommunications infrastructure that benefit industries and governments of the world whether developing or industrialized; geographically homogeneous or diverse; or low, middle, or high income. The flexible nature of the service allows it to be applied in many ways to meet changing needs. This paper provides an overview of the Final Analysis Infosat system.

INTRODUCTION

Telecommunications: Evolving to Serve New Needs

Telecommunications, defined as the science and technology of communication by electronic transmission of pulses, is rapidly evolving to serve the ever-increasing need for local, national, and international communications of all types from video to voice to data services. Traditional wire systems continue to play a major role in telephony and data communications in areas where a wire infrastructure exists. However, new wireless telecommunication systems are emerging. Both terrestrial and space-based systems exist, each with its own advantages, disadvantages, and price characteristics. The emergence of these systems has enabled a variety of new uses tailored to the applications, thereby improving the benefit and cost of the service.

The Benefit of Wireless Communications

Providing clear advantages over wire-based systems, terrestrial wireless communications has enabled freedom of movement, has broken down geographical barriers, and reduced the infrastructure, creating further access to telecommunications, and flexibility in the way we live and operate. However, terrestrial wireless systems have their limits. They have infrastructure costs that limit their economic viability in low density areas; they have geographical constraints; and they are subject to natural disasters.

Hence the advent of space-based wireless system. With space-based wireless systems, typically provided by geostationary satellites, many geographical and density-related economic barriers have been broken. This has proven the advantages of space-based communications over terrestrial wireless systems, and has enabled telecommunications to reach many areas of the world not able to receive such services in the past. However, geostationary satellites do not provide all of the answers. By virtue of their orbit they have fixed service areas; they have a large and expensive single point of failure; and they require large and expensive ground systems to communicate with the satellites parked at very high altitudes above the earth. Their services are

therefore not accessible to many segments of the population, nor economical for many industrial or large scale environmental applications.

The Emergence of Low Earth Orbiting Wireless Systems

In response to these needs, and enabled by trends in space technology, we see the emergence of a new class of space-based wireless systems called LEOs. These constellations of low earth orbiting satellites expand the benefits of space-based wireless systems beyond that of the traditional geostationary satellites. They provide global coverage, they serve low and high density areas at the same price points, they have scalable applications from one to millions of terminals, they avoid the single point of failure of geostationary satellites, and due to their low altitude, they require less expensive ground terminals. They are good, low cost alternatives to geostationary satellites, and they offer significant advantages over the wireless terrestrial solutions. They provide a new, powerful, and cost-effective approach to regional and global communications, free of restrictions.

Within the set of proposed low earth orbiting satellite systems, there exists two distinct classes (Figure 1). One class provides high bandwidth voice, and the other provides narrowband digital data services. The digital data service systems are called Little LEOs or Infosats. With an infrastructure consisting of a constellation of satellites in low earth orbit; small, low cost ground terminals; and versatile ground collection sites, these systems provide a "global area network" with multiple space and ground nodes for flexible data communications.

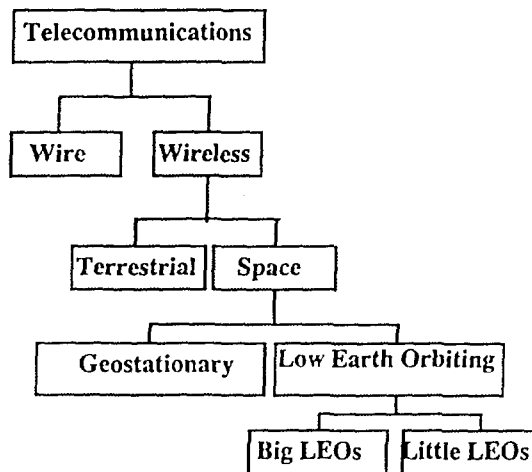


FIGURE 1: A Telecommunication System Hierarchy shows the evolution of wireless systems including today's newcomers: Low Earth Orbiting (LEO) systems.

With services across a broad set of government, industrial, or personal applications, Infosat systems provide a niche telecommunications infrastructure that benefit nations of the world whether developing or industrialized; geographically homogeneous or diverse; or low, middle, or high income. The flexible nature of the service allows it to be applied in many ways to meet changing needs.

THE FINAL ANALYSIS "INFOSAT" SYSTEM

The Final Analysis system consists of four segments (Figure 2): 1) space segment, 2) ground segment, 3) user segment, and 4) operations segment. A brief overview of each is provided.

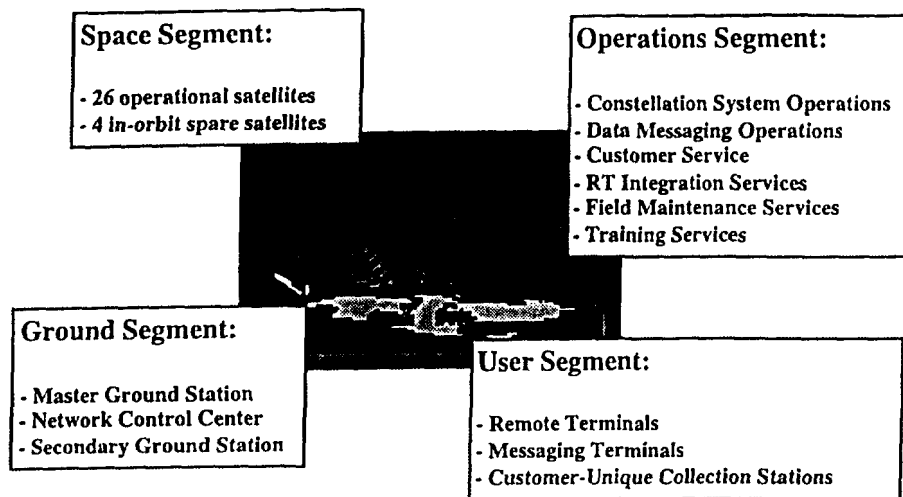
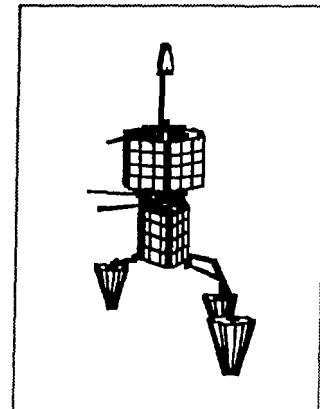


FIGURE 2: The Final Analysis Infosat system consist of four main segments comprising the end-to-end system and the major operations tasks to operate the service.

Space Segment: Twenty-six satellites in low earth orbit comprise the space segment. The satellites are small, low cost, powerful systems that benefit from the miniaturization and advanced flight processor technology that has resulted from the US space program. Key characteristics of the satellites are described in Table 1.

Two of the satellites are launched to an 83-degree inclined orbit at 1000 km. Twenty-eight (28) satellites are launched seven each into four orbit planes inclined at 66 degrees and phased 90 degrees in right ascension. They are also at 700 to 1000 km (TBD). Of the 28 satellites, 24 are primary commercial satellites with four acting as in-orbit spares (one each per orbit plane). With multi-channel flight radios and a 5600 km footprint, the constellation provides nearly continuous coverage of the globe for store and forward telecommunications with millions of remote ground terminals.



The commercial satellites are launched aboard the Russian Cosmos launch vehicle from the Plesetsk Cosmodrome in northern Russia, providing a low cost, reliable flight to orbit. With over 700 launches and a success rate of 99.1% (229 out of 231) since 1986, this vehicle is the most reliable in its class. Available inventory, ample launch site capability, and a short Russian prelaunch process allows for flexible and quick launch scheduling. The launches are insured. Final Analysis has a joint venture agreement with Polyot Design Bureau for the launch service, and has the support of the Russian Space Forces under the Ministry of Defense, and export/import processes are in place.

The satellites will be launched in groups with launches occurring approximately once per year. The first two satellites will be launched in 1997 to the 83 degree inclined orbit. The 66-degree inclined satellites will be launched in four groups of seven satellites. Each group will occupy a single Cosmos vehicle, with a group launched each year through 2001 to complete the constellation.

TABLE 1: Key Characteristics of the Final Analysis Infosat Commercial Satellites Are Provided By Subsystem.

Subsystem Characteristics	Subsystem Characteristics
Mechanical Configuration:	RF:

<ul style="list-style-type: none"> • Right 6-sided polygon, approx. 150 kgs • Antenna, gravity gradient boom, and solar array deployments • First fundamental modes ≥ 35 Hz 	<ul style="list-style-type: none"> • UHF/VHF multi-channel digital composite transceivers • Variable uplink rate to 19.2 kbps • Variable downlink rate up to 128 kbps • Spiral and composite whip antennas • GMSK modulation
Attitude Control & Determination: <ul style="list-style-type: none"> • Gravity-gradient • Sun pointing mode for solar array illumination • Pointing to ± 1 degree of local vertical • Torquers, Magnetometer, Sun Sensors • Autonomous operations with ground intervention 	C&DH Subsystem: <ul style="list-style-type: none"> • RISC 6000 32-bit processor • 160 Mbytes onboard memory • Onboard LAN • Packet data protocol • Real-time and stored command capability • GPS time • Health and safety onboard monitor & control
Orbit: <ul style="list-style-type: none"> • Onboard Global Positioning System (GPS) 	Thermal: <ul style="list-style-type: none"> • Passive system (blankets, paints, etc.)
Power: <ul style="list-style-type: none"> • 28V \pm 6V DC (unregulated bus) • 180 watt generation capability • Three 9-amp-hour batteries • Onboard charge control (V/T intercept, Charge/Discharge Ratio) 	Propulsion: (66 degree inclined satellites only) <ul style="list-style-type: none"> • Cold gas • Used for in-plane orbit phasing of constellation
Note: Bus capabilities are approximate and are subject to change as design options are explored and groups of satellites are built.	

The Final Analysis Infosat commercial satellites have also been designed with additional volume, mass, power, and data services to accommodate an additional payload. Called the Secondary Payload Program, the commercial satellites have the ability carry an experiment to orbit. The program is designed to provide low cost, quick access to space to compliment the ground-based measurements. In this way the Infosat system not only provides telecommunication services for ground assets, but it enables space/ground research campaigns.

Ground Segment: The ground segment provides satellite communications, control, health and safety monitoring, performance trending, mission and user data service planning and scheduling, data message processing and distribution, and customer service. It is comprised of the Master Ground Station (MGS) and Network Control Center (NCC) located in the Mission Operations Room at the Final Analysis Lanham facility, and several command and control RF stations, and a network of gateway RF stations.

The MGS is a multi-string system for planning, scheduling, real-time command and control, and performance trending of the satellites. It supports multiple satellites, uses state of the art and proven technology. The NCC is currently under system engineering, and will provide message service planning, message processing and distribution, logistics support, and customer service. The MGS and NCC are under development by a team consisting of Altair Aerospace, Computer Sciences Corporation, and Autometric Inc..

Command and control RF stations for the launch of the first satellite will include sites at Lanham, Md., Logan, Utah, and Andoya Rocket Range, Norway. This compliment of stations will provide satellite-to-ground communications every 100 minutes or so, allowing for ample time to uplink

commands and retrieve data. Additional sites will be added as the constellation is deployed. They use proven, commercially available RF equipment. Consisting of a yagi antenna, and antenna controller, a ground radio, switches and duplexers, and a UNIX-based system for control, the system is compact, low cost, and operates under remote control from the MGS.

The gateway stations are receive-only sites located at National Service Provider facilities in the countries authorizing the Final Analysis system. They will also be located at key customer sites as desired by the customer to provide direct downlink of customer data. The gateway stations are also low cost systems using commercially available equipment and containing subsets of the NCC functionality for local message processing and distribution, and customer service.

User Segment: The user segment consists of the ground Remote Terminal (RT). The RT is a low cost, small, processor controlled RF modem used to communicate with a ground asset to collect and send messages to and from the satellite. It has a flexible interface and can be programmed with application software to provide "smart terminal" services local to the ground asset, and can host GPS receivers to collect position data.

The RT is tunable across a range of VHF and UHF bands; uses GMSK modulation; uplinks data at rates up to 19.2 baud; receives data at 9.6 baud; and operates on DC power. It has a low power sleep mode and is activated by a beacon from the satellite. The satellite uses a frequency scanner to select an available channel, then directs the RT to use that channel. Multiple RTs are activated as a group and a Time Division Multiplex scheme is used to uplink data from the selected RTs to the satellite.

A prototype RT has been developed. This prototype RT (Figure 3) provides the functionality of the commercial version using commercially available technology. Packaging of the commercial versions are expected to be much smaller. The prototype has been tested with the flight radio in the lab. On-orbit testing will commence in the second quarter of 1997 with the launch of the FAISAT-2v satellite, the second in a two-satellite test program ahead of commercial satellite deployment.

RT development continues at Final Analysis, with the commercial version expected to come in a variety of configurations. Over the next year Final Analysis will develop a lower power, smaller, RT for commercial high volume production.

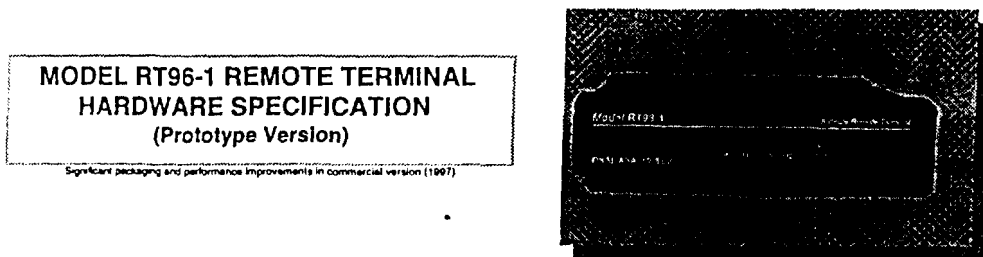


FIGURE 3: The Final Analysis prototype RT provides the functionality of the commercial RT version. It has an embedded processor (386 with PC functionality) and optional GPS card, and interfaces with external sensors and actuators (data loggers, environmental sensors, etc.) through a RS-232 port.

Operations Segment: The operations segment consists of a variety of tasks to operate and control the satellites, provide data messaging services, and conduct the field activities. Final Analysis will conduct satellite, ground system, and data messaging operations, acting as the wholesale telecommunications service provider.

Primary marketing, sales, and service to the commercial Infosat customers will be provided by Value-Added Resellers (VARs) in the US market, and by a network of National Service Providers (NSPs) in the international market. The VARs and NSPs will provide the custom engineering, systems integration, and field operations for RT installation, test, and maintenance. They will also provide customer service. The NSPs will have the additional responsibility of obtaining the national RF license from the host country, and for developing and operating the gateway station. Local businesses in the host country will be selected to provide NSP services, allowing for industry and economic development within the host country.

System Operations

The Infosat system offers two distinct types of services: 1) scheduled two-way communications, and 2) event-driven communications. Scheduled communications provide routine data messaging with the remote assets. They are defined by the customer, scheduled through the Final Analysis NCC, and executed by the satellite onboard processor through RF communications with the RT. Scheduled communications are generally planned well in advance, but can be performed on-demand by the customer. Turnaround time for executing customer requests for communications will vary based on the number of satellites in orbit during constellation development.

The operations scenario for scheduled communications is illustrated in figure 4.

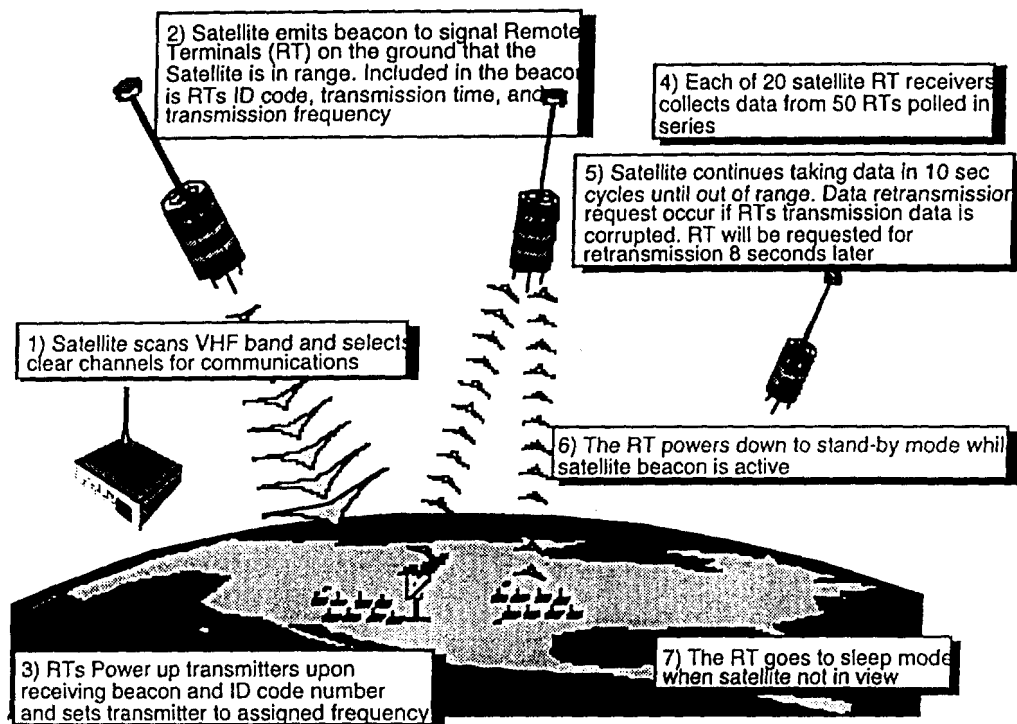


FIGURE 4: The Infosat satellite initiates communications through a beacon to the RT at a scheduled time loaded onboard the satellite processor. Multiple RTs are read across a 10 second data arc. Prior to initiating the communication, the satellite scans the frequency channels and selects an available channel to avoid interference. The communication protocol includes forward error correction and retransmission for better than 10^{-5} BER.

Event-driven communications enable data messaging in response to ground-based conditions (such as alerts). They are initiated by the RT upon detection of the event condition, and are scheduled for immediate execution by the satellite processor.

Once the RT has been polled, the messages are downlinked to a ground collection station. If the collection station is within the footprint of the satellite (5600 km), the message can be transmitted immediately. If the ground collection site is outside of the footprint, the message is stored onboard until the satellite flies over the collection site.

A feature of Final Analysis system is its flexibility and smart terminal capability. The RT contains a 386 processor to allow for event control, data processing, and other functions at the remote site to reduce data communication needs, improve data results, and control operations. The satellite also contains a powerful processor which can be used for additional data and event manipulation. Finally, the ground system compliments the satellite and RT processing capability with additional planning and control logic. The ability to place the monitor and control logic at any point in the end-to-end data path provides flexibility to meet a variety of customer needs.

A summary of the five main operations processes and the associated options are as follows (figure 5):

1. **Polling and Control Plan:** A customer-defined polling and control plan is defined and loaded into the satellite(s) and the RT. Variations from the routine scenario are accommodated through special customer requests and are executed in near real-time (within minutes to hours depending upon the uplink site location, downlink site location, and number of constellation satellites in orbit). Further, applications software in the RT and/or satellite can be used to trigger variations in the polling scenario.
2. **Two-Way RT-to-Sensor Suite Communication Operations:** The RT or sensor initiates a communications session to retrieve and transmits messages to and from the RT based on time, data presence, or alert logic.
3. **Two-Way Satellite-to-RT Communication Operation:** The satellite initiates a communication session with the RT for routine operations, retrieving and sending data messages to the RT. Additionally, the RT can initiate a communication session based on a sensed-event.
4. **Two-Way Satellite-to-Collection Site Communication Operation:** The satellite downlinks retrieved messages from the RT to a gateway station or customer-unique collection site for processing and distribution. The satellite also receives any new instructions destined for the RT and ground asset. The communication scenario occurs quickly if the collection site is within the 5600 km footprint of the RT location, or is stored until the satellite travels the next logical gateway station.
5. **Collection Site-to-Data Processing & Control Site Communication:** The data is exchanged with the customer's data processing and control system via a variety of mechanisms, and customer service is provided.

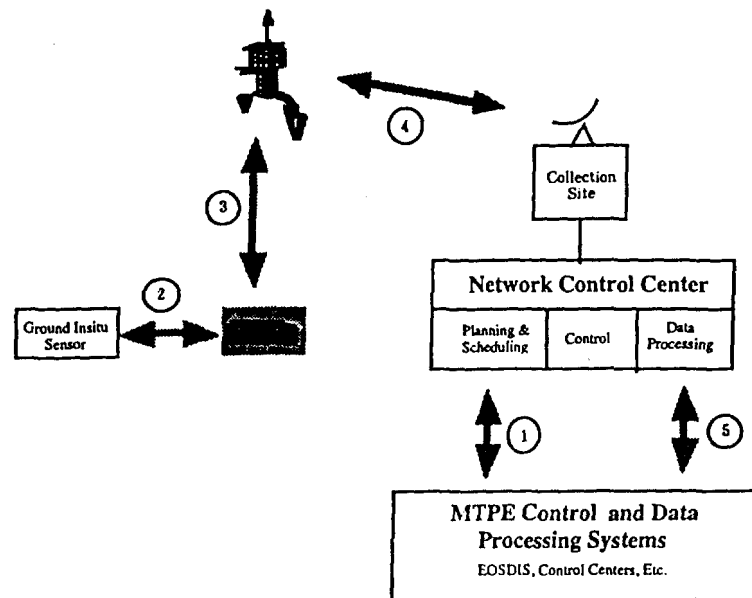


FIGURE 5: The communications operations scenario has five main steps. The communication can be initiated by the ground (sensor or RT event), or by the satellite per a customer-defined schedule.

The combination of satellite, ground, user, and operations segments provide a flexible “global area network” for store and forward messaging services that have significant advantages over wire, terrestrial RF and geostationary satellite systems. The infrastructure is flexible in its configuration and has broad orbital and ground coverage scope.

The Commercial Market

Infosat systems provide a variety of services that can be applied to many of industrial, consumer, and infrastructure applications. Table 2 lists the key services and market applications for Infosat systems. However, the uses are limited only by one’s imagination and it is likely that new applications will evolve.

TABLE 2: The Infosat system provides a variety of services to a variety of market applications, creating a strong commercial business plan.

Services	Applications
1. Data Acquisition 2. Asset Monitoring: a. Routine Monitoring b. Event Monitoring 3. Asset Tracking and Location Determination 4. Remote Supervisory Control 5. Two-Way Variable Messaging 6. Remote E-Mail and Small File Transfers 7. Alert Monitoring	1. Utility Industry 2. Transportation Industry 3. Scientific Organizations 4. Environmental Organizations 5. Oil and Gas Industry 6. Agribusiness Industry 7. Automotive Industry 8. Personal and Business Messaging

The Infosat systems have been the subject of a variety of market studies¹, all of which have confirmed strong growth market that will support several suppliers². According to a market research report prepared by a large market research firm, the Little LEO market is expected to be \$5.5B by 2002. It is a global market in which the US industry has a commanding lead in the technology and implementation. As such, it supports US industry, economic, trade, and job development.

Test marketing has yielded a variety of unique applications. For the utility industry, currently under the pressures of deregulation and increased competition, it offers automatic meter reading, an information link to the residential consumer for demand side management and rate scheduling on the home PC, load control, tamper and power outage alerts, transmission grid and remote substation monitor and control, and so forth.

For agribusiness, the system will compliment remote sensing images to provide ground truth measurements, and allow for the remote control of irrigation, fertilizer application, and so forth. For environmental applications, the system supports remote field data collection from sensors such as volcano tilt meters, GPS stations, water monitoring stations, ocean buoy stations, glacier monitoring stations, and general ground insitu and space instrument calibration instruments. The systems can also be designed to provide hazard alerts of impending natural disasters such as volcanic eruptions and floods.

For the transportation industry, the system enables tracking of trucks, shipping containers, and rail cars. Tracking of cargo through the intermodal process is also possible, as is the collection of cargo-related data such as vibration, environmental data, and security information to assist in theft reduction, loss, and insurance claim litigation.

The automotive industry can apply the system to smart car applications to allow remote monitoring of the auto's performance for preventive and corrective maintenance and the collection of reliability information. Roadside assistance is another application.

The system supports variable two-way messaging for personal and business applications, as well as remote e-mail access from a laptop with a satellite communication terminal that acts as an e-mail server, relaying the information to the satellite for downlink to a gateway and input to the internet.

The system can be used for supply operations, allowing for the supply depot to be remotely monitored for supply status and thereby improving supply inventory ordering and supply operations. Applications include oil and gas, vending machine, agriculture supply, and other operations.

As can be seen, the applications are many, and are limited only by the creativity of the designer. The system enables new information and control points in a system for improved operations efficiency and increased service to the end user. The low terminal costs (\$100 to \$500 depending on options and packaging, and in quantity) and the small transmission fee (approx. \$0.25 per message) means the use of such service is economically viable in many of these applications.

ITU REGULATORY REQUIREMENTS

The implementation of the Infosat technology requires the allocation of additional radio frequency spectrum below 1 GHz, a topic currently in policy discussions within the International Telecommunications Union (ITU) and its regional entities, and is on the agenda for the World Radio Conference-97 in Geneva. ITU members will be asked to vote on the allocation of additional spectrum to allow these systems to go forth with full implementation. To assist this process, Final Analysis has offered free satellite time with our next test satellite, FAISAT-2v, to be launched by

the first quarter of 1997. This free time will allow member ITU countries to measure and assessed the impact of frequencies under consideration by the ITU for allocation to Infosat services.

SUMMARY

The declining cost of space access and satellites has enabled a new class of telecommunication systems: constellations of low earth orbiting satellites. One such set of systems provide low cost, geographically unconstrained, global, store and forward digital data communications with a flexible set of services applicable to a host of industries, government agencies, and consumers. These systems are in the early development stages, and as they are deployed will create new ways of operating and providing end user service.

Acknowledgments

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